Effect of Vermicompost and Organic Formulations on Yield and Quality of Soybean Grown on Vertisol

Abstract

The field experiments were conducted during *kharif*-2020 and *kharif*-2021 at Research Farm, Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV Parbhani, to study the effect of vermicompost and organic formulations on yield and quality of soybean grown on Vertisol. The experiment was laid in factorial randomized block design with twelve treatments and three replications. Experimental treatments consist of two factors in which one factor consist of vermicompost consist of three levels C_1-RDF, C_2- Vermicompost eq. to RDN, C_3- Vermicompost eq. to RDN + RD of vermicompost @ 5 t ha^{-1}, another factor organic formulations consist of four levels OF_0- control, OF_1- Pancahgavya, OF_2- Beejamruth + Jeevamruth, OF_3-Beejamruth + Jeevamruth + Pancahgavya. The yield parameters like no. of pods, seed and straw yield and quality parameters like protein content and test weight showed significant increased with the application of RDF as compared to other treatments. Among organic formulations treatments highest value was recorded in combined application of Beejamruth + Jeevamruth + Pancahgavya (OF_3) as compared to alone application. The significant increase in seed and straw yield was recorded in treatment receiving RDF (C_1) along with combined application of Beejamruth + Jeevamruth + Pancahgavya (OF_3). The result of the experiment revealed that application of RDF along with combined application of Beejamruth + Jeevamruth + Pancahgavya was found beneficial for increase in yield and quality of soybean grown in Vertisol.

(Key words: Vermicompost, organic formulations, inorganic fertilizer, yield, quality, soybean)

Introduction

Soybean [*Glycine max* (L.) Wilczek] is globally important oilseed crop and source of high quality protein for human consumption, used as fodder for animal and is also important crop rotation systems (Manyong *et al*. 1996). India ranks fifth in area and production of soybean after USA, Brazil, Argentina and China (FAO, Stat 2015). In India, to get the more food the farmers are using the chemical fertilizers continuously without knowing the actual dose and their residual effects on soil properties. The continuous use of chemical

fertilizers has led to reduction in the crop yield and resulted in imbalance of nutrient in the soil, which has adverse effects on physical, chemical and biological properties of soil and thereby affecting the sustainability in crop production. Under these imbalanced conditions various beneficial soil microorganisms are being adversely affected and resulted reduction in crop yield and imbalance of nutrients in the soil which has adverse effects on soil health. Neither inorganics nor organics alone can maintain organic matter status of soil and sustain productivity (Prasad, 1996). To alleviate the problem, integrated nutrient management is the best method in the maintenance of soil fertility and supply of plant nutrients to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Patel and Thanki, 2020). There is growing interest in using organic manures as a source of nutrient supply to crop production for long-term soil productivity, ecological stability and reducing the need for chemical fertilizer. Among the various organic manure sources, FYM and vermicompost are readily available on the market. Integration of inorganic and organic manures not only sustains crop production but also improves soil health and nutrient use efficiency (Verma *et al*. 2005).To achieve sustainable soil fertility and crop productivity, the role of organic manures and other nutrient management practices like use of fermented organic nutrients *viz*. Jeevamruth, Beejamruth and Panchagavya etc. are becoming popular among farmers. These fermented liquid organic fertilizers contain in addition to nutrients, numerically microorganisms and growth promoting substances which help in improving plant growth, metabolic activity and resistance to pest and diseases.

Material and Methods

The research trials were carried out during *Kharif*-2020 and *Kharif*-2021 at Research Farm, Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV Parbhani, to study the effect of vermicompost and organic formulations on yield and quality of soybean grown on Vertisol. The experiment was laid out in factorial randomized block design with twelve treatments and three replications. Experimental treatments consist of two factors in which one factor consist of vermicompost consist of three levels viz., C_1-RDF, C_2-Vermicompost eq. to RDN, C_3- Vermicompost eq. to RDN + RD of vermicompost @ 5 t ha^{-1}, another factor organic formulations consist of four levels OF_0- control, OF_1- Panchagavya, OF_2-Beejamruth + Jeevamruth, OF_3-Beejamruth + Jeevamruth + Panchagavya. The soybean variety

'MAUS-162' was sown at spacing 45 cm row to row and 5 cm plant to plant. Seeds were treated with beejamruth just before sowing. The vermicompost was incorporated about 8 days before sowing respectively and RDF was applied at the time of sowing as per treatments. All other operations were performed as per recommendations of the crop. The soil of the experimental site was dominant in montmorillonite mineral followed by moderate amount of kaolinite type of mineral and traces of Illite mineral. The data on various yield attributes and seed and straw yields and quality parameters like protein content and test weight were recorded under various treatments.

Result and discussion

Effect of vermicompost and organic formulations on yield attributes and yield of soybean

Number of pods per plant

The number of pods at harvest of soybean was significantly influenced by different vermicompost and organic formulation treatments presented in Table 1. The significantly highest number of pods (88.41) was recorded in the treatments with RDF (C_1) and it was statistically at par with number of pods (83.04) was reported with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Application of different organic formulations increased number of pods. Among, organic formulation treatments the significantly highest number of pods (92.06) was observed in combined application of Beejamruth+ Jeevamruth + Panchagavya (OF_3) and it was statistically at par with the number of pods (87.89) was observed in treatment with Beejamruth + Jeevamruth (OF_2). The interaction effect of vermicompost (C) and organic formulations (OF_3) regarding number of pods at harvest was found non-significant. Increase in number of pods per plant might be due to the significant increase in growth parameters and efficient nutrient utilization. It may also be due to adequate availability of major nutrients which are required in larger quantity thus directly helps the plants to increase crop yield. Similar results was also reported by Patel and Thanki (2020) and Gowthamchand *et al*. (2019). Somasundaram and Amanullah *et al*. (2003) reported that significantly higher number of seeds per pod recorded with panchagavya 3% as compared to other treatments.

Seed yield

The data pertaining to seed yield as influenced by vermicompost and different organic formulation treatments presented in Table 2. Significantly highest seed yield (2284.00 kg ha^{-1}) was recorded in the treatment with RDF (C_1) and it was statistically at par with seed yield (2198.00 kg ha^{-1}) was observed in the treatment with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Further, organic formulations alone or in combinations also significantly influenced the seed yield of soybean. The significantly highest seed yield (2335.00 kg ha^{-1}) was recorded in the treatment with Beejamruth+ Jeevamruth + Panchagavya (OF_3) over rest of the treatments. The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded highest seed yield (2600.00 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3). The increase in seed yield in the treatment receiving only RDF along with combined application of Beejamruth + Jeevemruth + Panchagavya may be due to adequate supply of essential major nutrient in addition to this more phosphorus supplied through RDF as compared to other treatment. While, increase in seed yield could be attributed due to the beneficial effect of jeevamruth cause more vigorous and extensive root system of crop leading to increased vegetative growth means for more efficient sink formation and greater sink size. It also increases biological efficiency of crop plants enhanced the level of soil microorganisms and enzyme activities and promoted the recycling of nutrients that may be released slowly during crop growth which ultimately led to increase in seed yield Moreover, IAA and GA present in panchagavya when applied as foliar spray could have treated as stimuli in plant system and increase the production of growth regulators in the cell system and the action of growth regulators in plant system ultimately stimulated growth and development. These results are in agreement with the findings of Kachave *et al*. (2021) reported that significantly highest fruit yield of tomato was obtained with treatment RDF + Beejamruth + Jeevamruth + Panchagavya. This might be due to adequate supply of required nutrients through chemical fertilizers and also overall improvement in soil physico-chemical and biological properties due to combined application of organic formulations. Jagdale *et al*. (2020) opined that increased seed yield of soybean was observed with the application of RDF along with combined application of beejamruth + jeevamruth + panchagavya.

Straw yield

Data narrated in Table 2 related to straw yield of soybean was increased significantly due to vermicompost and organic formulations treatments. The significantly maximum straw yield (3860.00 kg ha^{-1}) was found in the treatment with RDF (C_1) over rest of the treatments. It was followed by the treatment with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3). Minimum straw yield (3519.00 kg ha^{-1}) was found in treatment with Vermicompost eq. to RDN (C_2). Similarly, application of different organic formulations significantly influenced straw yield of soybean and highest straw yield (3947.00 kg ha^{-1}) was noted in treatment with Beejamruth+ Jeevamruth + Panchagavya (OF_3) over rest of the treatments. The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded straw yield (4299.00 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3). The interaction effect of vermicompost (C) and organic formulations (OF) was found statistically significant and recorded straw yield (42.99 kg ha^{-1}) in the treatment RDF (C_1) along with application of Beejamruth+ Jeevamruth + Panchagavya (OF_3). The results of present investigation revealed that combined application of Beejamruth + Jeevamruth + Panchagavya along with RDF improved straw yield. The organic formulations improve the microbial and enzymatic activity in soil and it provides adequate supply of nutrients at critical growth stages of soybean as well as presence of growth regulators contributing to higher straw yield. Jeevamrutha contains enormous amount of microbial load which enhances the microbial activity in soil upon its application, while panchagavya act as a source of nutrients besides producing hormonal effect. These results are also in conformity with the findings of Shwetha and Babalad (2008), who found that higher straw yield of soybean in combined application of organic manure along with fermented organics viz., beejamruth, jeevamrutha soil application and panchagavya foliar spray. These results are in conformity with the findings of Kachave *et al*. (2021) found that significantly higher dry matter yield with treatment RDF + Beejamruth+ Jeevamruth + Panchagavya. Further, Kasbe *et al*. (2015) who reported that better nutrient status of jeevamruth formulation (2500 litre ha^{-1}) resulted in profused growth in the form of higher dry matter accumulation and yield parameters.

Quality parameters

Protein content

The data regarding to seed protein content of soybean is presented in Table 3. Data clearly indicated that protein content of soybean was significantly influenced due to vermicompost and organic formulation treatments. The significantly highest seed protein content (36.19 per cent) was recorded in the treatment with Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3) and it was followed by the treatment with Vermicompost eq. to RDN (C_2). Lowest protein content (35.16 per cent) in seed was noted in treatment received only RDF (C_1). Among the organic formulation treatments the significantly highest seed protein content (37.47 per cent) was reported in the treatment with combined application of Beejamruth+ Jeevamruth + Panchagavya (OF_3) and lowest value was recorded in control treatment (OF_0). The interaction effect of vermicompost (C) and organic formulations (OF) regarding seed protein content was found significant. Significantly highest seed protein content (39.91 per cent) was recorded in treatment Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3) in combination with Beejamruth+ Jeevamruth + Panchagavya (OF_3). Result revealed that the protein content is directly related to N content. The increase in protein content might be due to supply of more N through vermicompost as compared to RDF alone. It was also improved significantly due to the application of jeevamruth base organic liquid formulations. The significant increment may be ascribed to different structural and functional roles of macro and micro-nutrients and growth hormones at cellular level which resulted from higher nitrogen content in seeds. Our results are in line with the report of Sornalatha and Esakkiammal (2018) concluded that the improvement in quality of crops observed with the use of liquid products such as beejamruth, jeevamruth and panchagavya. Sahay *et al*. (2016) who reported that protein content of pigeonpea was significantly increased with fertility levels and maximum reported with treatment 100% RDF + 5t FYM +Rh + PSB.

4.1.4.2 Test weight

The data presented in Table 3 shows that test weight of soybean was significantly influenced due to vermicompost and organic formulation treatments. The significantly highest test weight (12.94 g) was noted in treatment received only RDF (C_1) and it was at par with the treatment (12.58 g) was observed in treatment with Vermicompost eq. to RDN + RD of

Vermicompost @ 5 t ha^{-1} (C_3). Further, organic formulations increased test weight of soybean and significantly highest test weight (12.86 g) was recorded in the treatment with combined

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})

application of Beejamruth+ Jeevamruth + Panchagavya (OF_3) and lowest value was recorded in control treatment (OF_0). The interaction effect of vermicompost (C) and organic formulations (OF) regarding test weight was found non-significant.

From the data it is concluded that the application of recommended dose of fertilizers (30:60:30 $N:P_2O_5:K_2O$ kg ha^{-1}) to soybean along with the Beejamruth (seed treatment), Jeevamruth (soil application @ 500 L ha^{-1} at 30 and 45 DAS) and Panchagavya (foliar spray @ 3 % at flowering and 15 Days after first spray) recorded significantly highest yield attributing parameters like number of pods, seed yield and straw yield of soybean and quality parameters like test weight and protein content was improved in the treatment Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1} (C_3) in combination with Beejamruth+ Jeevamruth + Panchagavya (OF_3).

Table 1. Effect of vermicompost and organic formulations on number of pods at harvest of soybean (Pooled data of two year)

Treatments	No. of pods at harvest
Factor I - Vermicompost	
C_1- RDF	88.41
C_2-Vermicompost eq. to RDN	78.65
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	83.04
S.Em.±	1.80
C.D. at 5 %	5.27
Factor II - Organic Formulations	
OF_0- Control	75.92
OF_1- Panchagavya	77.60
OF_2- Beejamruth + Jeevamruth	87.89
OF_3- Beejamruth+ Jeevamruth + Panchagavya	92.06
S.Em.±	2.08
C.D. at 5 %	6.09
Interaction (I X II)	
S.Em.±	3.59
C.D. at 5 %	NS

Factor I - Vermicompost		
C_1- RDF	2284.00	3860.00
C_2-Vermicompost eq. to RDN	1727.00	3131.00
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	2198.00	3519.00
S.Em.±	25.00	34.00
C.D. at 5 %	72.00	101.00
Factor II - Organic Formulations		
OF_0- Control	1860.00	3225.00
OF_1- Panchagavya	1962.00	3345.00
OF_2- Beejamruth + Jeevamruth	2122.00	3497.00
OF_3- Beejamruth+ Jeevamruth + Panchagavya	2335.00	3947.00
S.Em.±	28.00	40.00
C.D. at 5 %	83.00	117.00
Interaction (I X II)		
S.Em.±	49.00	69.00
C.D. at 5 %	144.00	202.00

Table 2. Seed and straw yield of soybean as influenced by vermicompost and organic formulations (Pooled data of two year)

Table 2a. Interaction effect of vermicompost and organic formulations on seed yield of soybean

Treatment	OF_0	OF_1	OF_2	OF_3	Mean
C_1	1944.00	2151.00	2441.00	2600.00	**2284.00**
C_2	1538.00	1615.00	1715.00	2040.00	**1727.00**
C_3	2097.00	2120.00	2210.00	2366.00	**2198.00**
Mean	**1860.00**	**1962.00**	**2122.00**	**2335.00**	
Interaction	**C (A)**	**OF (B)**	**AXB**		
SE±	25.00	28.00	49.00		
CD at 5 %	72.00	83.00	144.00		

Table 2b Interaction effect of vermicompost and organic formulations on straw yield of soybean

Treatment	OF_0	OF_1	OF_2	OF_3	Mean
C_1	3428.00	3696.00	4016.00	4299.00	**3860.00**
C_2	2922.00	3003.00	2929.00	3671.00	**3131.00**
C_3	3324.00	3336.00	3546.00	3870.00	**3519.00**
Mean	**3225.00**	**3345.00**	**3497.00**	**3947.00**	
Interaction	**C (A)**	**OF (B)**	**AXB**		
SE±	34.00	40.00	69.00		
CD at 5 %	101.00	117.00	202.00		

Table 3 Protein and test weight of soybean as influenced by vermicompost and organic formulations (Pooled data of two year)

Treatment	Protein (%)	Test weight (g)
Factor I - Vermicompost		
C_1- RDF	34.78	12.94
C_2-Vermicompost eq. to RDN	34.97	12.09
C_3-Vermicompost eq. to RDN + RD of Vermicompost @ 5 t ha^{-1}	36.19	12.58
S.Em.±	0.19	0.06
C.D. at 5 %	0.57	0.19
Factor II - Organic Formulations		
OF_0- Control	33.11	12.15
OF_1- Panchagavya	35.05	12.50
OF_2- Beejamruth + Jeevamruth	35.62	12.64
OF_3- Beejamruth+ Jeevamruth + Panchagavya	37.47	12.86
S.Em.±	0.22	0.07
C.D. at 5 %	0.66	0.22
Interaction (I X II)		
S.Em.±	0.39	0.13
C.D. at 5 %	1.14	NS

Table 3a Interaction effect of vermicompost and organic formulations on protein content (per cent) of soybean

Treatment	OF_0	OF_1	OF_2	OF_3	Mean
C_1	32.26	34.94	35.43	36.50	**34.78**
C_2	33.59	35.10	35.17	36.01	**34.97**
C_3	33.49	35.11	36.26	39.91	**36.19**
Mean	**32.26**	**34.94**	**35.43**	**36.50**	
Interaction	**C (A)**	**OF (B)**	**AXB**		
SE+	0.19	0.22	0.39		
CD at 5 %	0.57	0.66	1.14		

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